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**Forest
Service**

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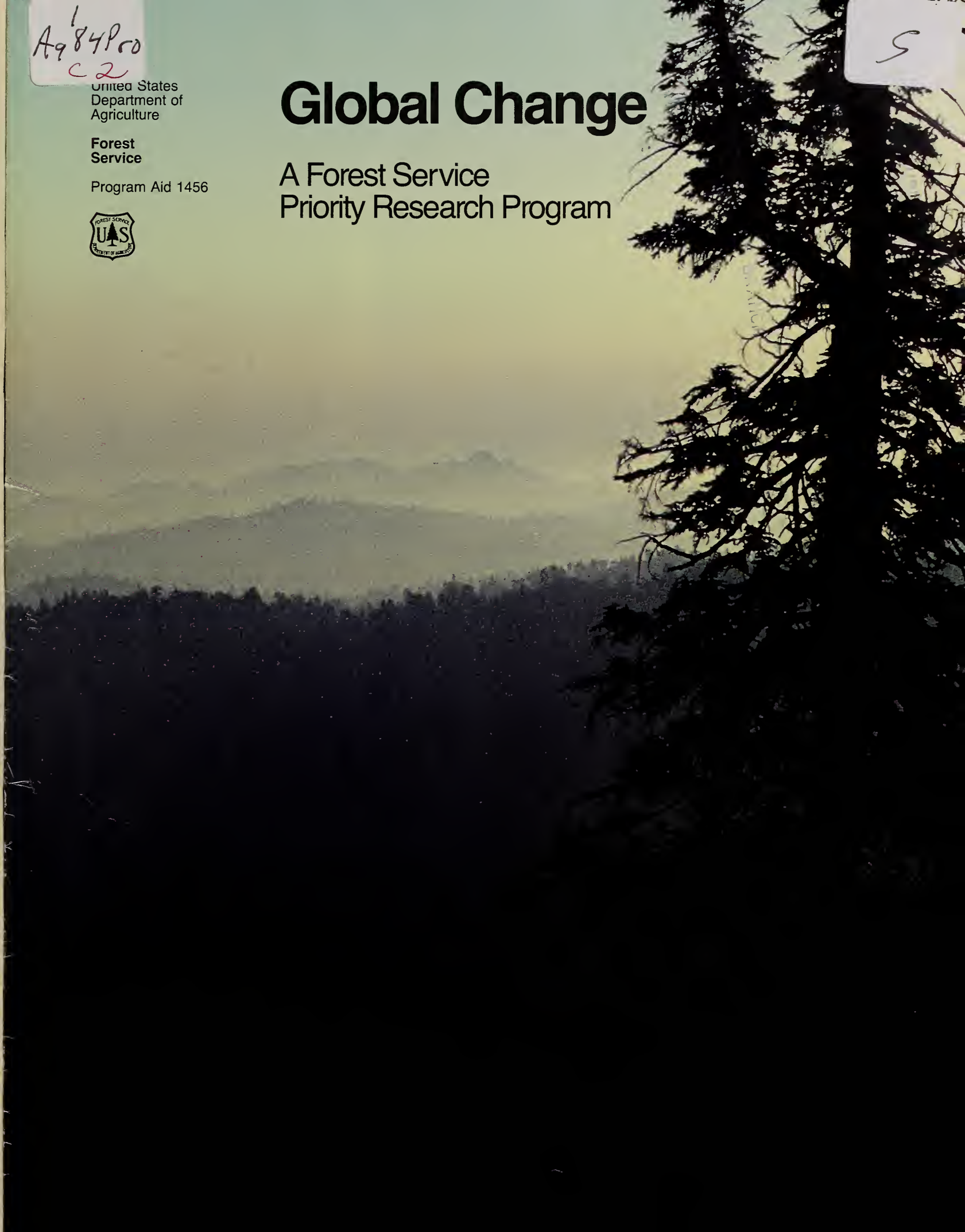
Global Change

A Forest Service Priority Research Program



Global Change—A Forest Service Priority Research Program

Necessity Makes It Hot

William Wordsworth probably did not know much about acid rain or other air pollutants. He certainly did not have an inkling about carbon dioxide buildup or the greenhouse effect. Information about forest decline was not available to him. Yet he could be describing a world where changes in global climate have led to severe changes in the form, function, and distribution of many types of trees. The poet could not have known the urgency for understanding the effects of climate change on the world's forests. We do.

Forests are a crucial resource in the climate change scenario. Not only do forests make up a third of the land area of the United States; not only do they provide fiber for timber, paper products and fuelwood; not only do they supply wildlife habitat, grazing land, recreation and scenic opportunities; and not only do they supply and protect much of the Nation's water supply—but forests also interact with the atmosphere in such a way that the Earth's ability to sustain global climate change might very well depend on their ability to moderate some of the effects.

The USDA Forest Service is pioneering the Global Change Research Program, which is dedicated to understanding the effects of climate change and air pollution on the Nation's forests. A total ecosystem approach makes this research program unique; necessity makes it hot.

. . . The earth was hard,

With weeds defaced and knots of withered grass;

No ridges there appeared of clear black mould,

No winter greenness. Of her herbs and flowers

It seemed the better part were gnawed away

Or trampled on the earth . . .

William Wordsworth

The Cold Facts

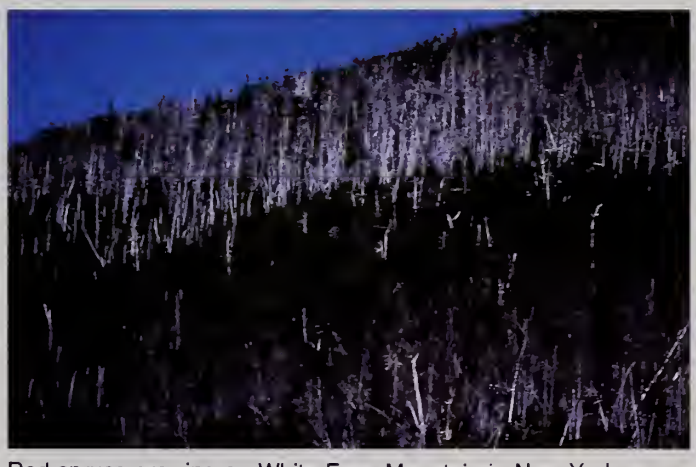
Climatic changes over the next 50 years could occur up to 100 times faster than during any period since people have lived on the Earth—so fast that the natural range of Douglas-fir could retreat northward towards Canada; so fast that loblolly pine could shift northward into the Corn Belt; so fast that some species may not keep up at all. Species at the southern limits of their range may die off entirely. Evergreens in the Great Lakes area could be replaced by hardwoods. The arid West could become even drier, leading to drought-stressed trees, which are more susceptible to attack from insects like gypsy moth and bark beetle. Drought combined with dry lightning strikes could increase the incidence and severity of forest fires. Public lands in the West supply much of that region's water, and global climate change could threaten the quantity and quality of that water.

Carbon dioxide is one of the primary gases contributing to the greenhouse effect, which raises the temperature of the globe by trapping heat inside the Earth's atmosphere. A dramatic increase in atmospheric carbon dioxide—brought about by the burning of fossil fuels and the clearing and burning of forests—is behind the rapid climate change now being predicted. The temperature of the globe is expected to rise between 4 and 7 degrees Fahrenheit over the next 50 years. In the past, warmings of this magnitude have taken 10,000 to 30,000 years to come about. A change in precipitation patterns will accompany this global warming. The frequency and severity of drought are expected to increase.

Consider what is going on in our forests right now, even without the dramatic effects of predicted climate change.

- Red spruce growing on several mountains in the Northeastern United States have died in alarming numbers. In addition to a harsh climate, acidic clouds and continuous high levels of ozone impact high-elevation spruce–fir forests in the Eastern United States.

Atmospheric carbon dioxide is responsible for global climate changes.



Red spruce growing on White Face Mountain in New York have died in alarming numbers.

Declining sugar maples in Vermont.

- Some of the most important commercial forests in the United States—the pine plantations and mixed pine–hardwood forests of the Coastal Plain and Piedmont regions stretching from Virginia to Texas—have experienced declining growth rates in some areas. Air pollution may be a contributing factor.
- Syrup-producing sugar maple stands (sugar bushes) have declined in some areas of the Northern United States and Canada's Eastern Provinces. The causes are being investigated.

When scientists combine these observations with the anticipated results of global climate change, the future for the Earth's forests looks even more bleak.

Warming Up

Research on the health and productivity of our Nation's forests in a changing atmospheric environment has been warming up at the Forest Service since 1984 in the form of the Forest Response Program (FRP). A cooperative effort between the Forest Service, the U.S. Environmental Protection Agency (EPA), and forest industry, the FRP has been studying the effects of atmospheric deposition and associated pollutants on forests across the country.

Four regional cooperatives conduct FRP research. The **Spruce-Fir Research Cooperative,** managed by the Forest Service's Northeastern Forest Experiment Station in Broomall, PA, is working to determine exactly why spruce–fir forests are declining at high elevations in the Eastern United States and what part acidic deposition and associated airborne pollutants are playing in that decline.

The **Eastern Hardwoods Cooperative,** also managed by the Northeastern Station, is surveying the condition of hardwood forests in the Eastern United States and looking at possible relationships between forest condition and atmospheric deposition.

Whether ozone exposure combined with sulfur and nitrogen deposition is damaging the health, productivity, and stability of commercial forests in the Southern United States is the concern of the **Southern Commercial Forest Research Cooperative,** managed by the Southeastern Forest Experiment Station, Asheville, NC.

The **Western Conifer Research Cooperative,** managed by the EPA Environmental Research Laboratory, Corvallis, OR, is studying the sensitivity of western forests to atmospheric deposition and related airborne pollutants and determining whether western forests are currently being damaged.

Each cooperative is a multidisciplinary, multiinstitution team of investigators. Research in the program is funded on a competitive basis. Other components of the FRP are the National Vegetation Survey, which is evaluating the extent and magnitude of recent changes in forest condition; the Atmospheric Exposure Cooperative, which monitors the exposure of forests to airborne chemicals; and the Acid Rain Team, which coordinates overall program planning and review. The team is made up of three projects—Assessment, Quality Assurance, and Synthesis and Integration.

The FRP operates under the auspices of the National Acid Precipitation Assessment Program, an interagency task force established by Congress with the Acid Precipitation Act of 1980 (Title VII of the Energy Security Act, Public Law 96-294).

Slated to end in 1990, the FRP has established a solid scientific foundation from which to address the hot research issues of global climate change.

The Hot Questions

The Forest Service has designed this priority research program to increase understanding of the many and varied interactions between forests, air, and the changing climate. Three key questions have emerged:

- **What processes in forested ecosystems are sensitive to physical and chemical changes in the atmosphere?**
- **How will future climate change influence the structures, function, and productivity of forest and range ecosystems?**
- **How will climate change affect forest management, and how must forest management activities be changed to sustain forest health and productivity?**

The studies grouped under the Global Change Research Program all share one objective: providing a scientific base of information that will enable policymakers to make wise decisions.

Researchers use chambers to expose seedlings, whole trees, or parts of trees to specific levels of pollutants.

The response of treated trees can then be compared to trees growing under natural conditions.

Research Sparks

Four broad elements spark the research and keep it focused.

Effects of the Atmosphere on Forests

Global climate change will result in changes in the basic bio-geo-chemical cycles. The distribution and composition of forests will change. The frequency and severity of insect and disease outbreaks will change. Water supplies will be altered. New research will emphasize the delicate relationships that may be disrupted as a result of climate change.

Effects of Forests on the Atmosphere

We want to know how wildfires, forest clearing, and forest management activities affect the global climate. The significance of land clearing in the Tropics and forest operations in temperate forests has not been adequately gauged.

Long-term Monitoring

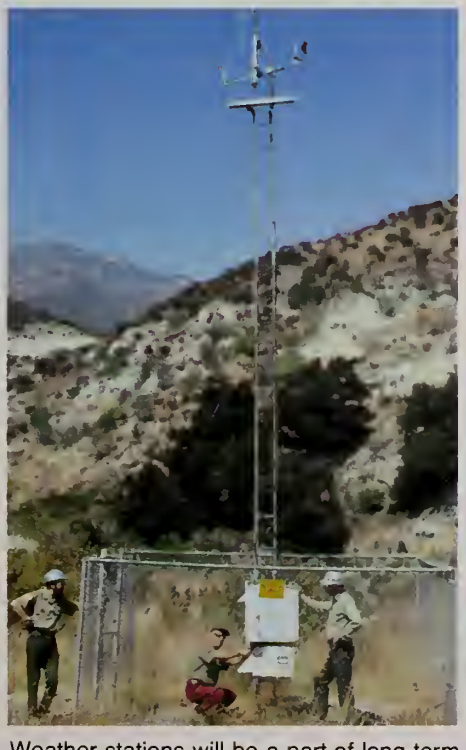
We will use long-term ecosystem monitoring to determine trends in forest condition; to assess current forest condition in relation to natural and human-caused stresses; and to identify those variables necessary to measure the response of forests to climate change.

Ecosystem Modeling

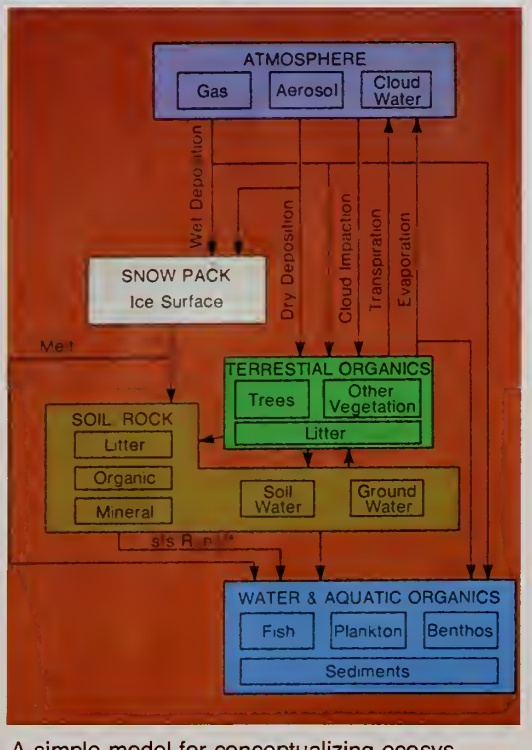
Quantitative methods to predict ecosystem changes are essential to the development of strategies for managing forests in a changing environment. Some models will have direct management applications, while others will be useful for conceptualizing ecosystem processes; still others will be useful in making policy decisions.

Ponderosa pines killed by an outbreak of mountain pine beetle.

Climate change may affect the frequency and severity of forest and rangeland fires.



Weather stations will be a part of long-term monitoring network.



A simple model for conceptualizing ecosystem processes.

Hot Expectations

A major expectation of this program is improved predictions of forest composition and distribution in response to air pollution and climate change. The program is also expected to provide answers to specific resource management and protection questions. For example, how will changes in forest health and productivity affect:

- future timber supplies and the quality of forest products?
- habitat for threatened and endangered species?
- future water supply and quality?
- recreational opportunities?
- frequency and severity of insect and disease outbreaks?

Long-term benefits will be resource protection and even a reversal in adverse effects of global climate change. The bottom line will be the development of a scientific basis for making major policy decisions.

Managing The Change

The research infrastructure of the Forest Service provides the necessary backbone to manage a research program of this magnitude. The Deputy Chief for Research coordinates Forest Service research nationally. Eight Experiment Stations throughout the United States maintain staffs of capable scientists and experienced technical and support people. Cooperative relationships with universities, other Federal agencies, and private industry allow the Forest Service to draw on topnotch expertise. The Forest Service manages the land base needed for this wide-ranging program. Experimental Forests and National Forests across the continental United States and in the Tropics and Pacific islands represent a multitude of forest types for study. But most important, through the Forest Response Program, the Forest Service has become a national leader in research on the environmental effects of atmospheric change.

The Forest Response Program has addressed acid deposition and other forms of air pollution through a total ecosystem approach. That research program has provided us with a model and a base. We can build on it now. The Forest Ecosystems and Atmospheric Pollution Research Act of 1988 (Public Law 100-521) has already designated the Forest Service as the lead agency to continue research begun under the National Acid Precipitation Assessment Program and carried out by the Forest Response Program. Although the FRP ends in 1990, research on air pollution and forests will continue, under Public Law 100-521, as a major component of our priority research program on global change.

The Global Change Research Program of the Forest Service is a fully integrated part of the U.S. Global Change Research Program (USGCRP) developed by the President's Office of Science and Technology Policy's Committee on Earth Sciences. The purpose of the USGCRP is to facilitate planning and coordination of the many Federal research and budget activities on global change.

We have the experience and the scientific, technical, and administrative resources. We have the land base. We have a mission: to protect the health and productivity of America's forests, and by extension the forests of the world. The heat is on.

For further information about this research program, contact:

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The Hubbard Brook Experimental Forest in New Hampshire is one of many Forest Service sites where a long research history will provide a headstart on the study of global climate change.

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